TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME X, No. 2, pp. 25-60, plates 3-4, figs. 1-5

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NEW MOLLUSKS FROM THE ROUND MOUNTAIN SILT (TEMBLOR) MIOCENE OF CALIFORNIA

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SAN DIEGO, CALIFORNIA
PRINTED FOR THE SOCIETY
DECEMBER 30, 1943

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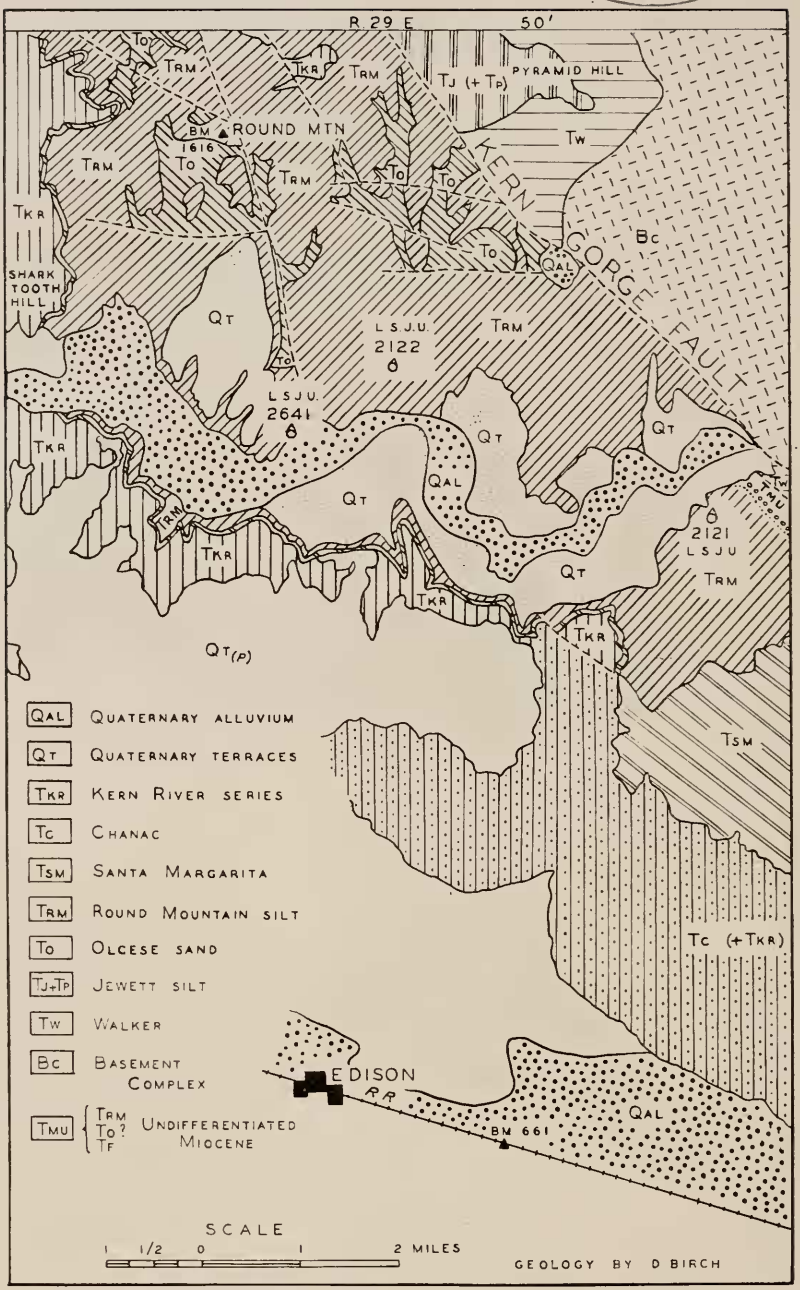

Fig. 1. Geology of the Kern River area near Round Mountain. The course of Kern River is marked by the band of Quaternary alluvium near the center of the map.

NEW MOLLUSKS FROM THE ROUND MOUNTAIN SILT (TEMBLOR) MIOCENE OF CALIFORNIA[1]

BY

A. Myra Keen

Stanford University

Abstract

Nineteen new species of mollusks are described and one new pelecypod subgenus proposed—*Bornia (Temblornia)*. All material discussed comes from outcrops along Kern River, in the Round Mountain silt member of the Temblor formation. Study of the fauna indicates that it is of lower to middle Miocene age and is probably a correlative of some part of the Alum Bluff formation of Florida. In the discussion of comparative material, a homonym, *Typhis* (*Talityphis*) *costaricensis* Olsson, 1942, not Olsson, 1922, is renamed *T.* (*T.*) *olssoni*.

Acknowledgments

As indicated in the body of the paper, I am greatly indebted to Mr. Donald C. Birch and Mr. Robert T. White for specimens, maps, and advice. Professor Hubert G. Schenck has read and criticised the typescript and has suggested many improvements. In addition I have received aid in various ways from Professor Konrad Krauskopf, Miss Elizabeth A. Watson, Miss Lois T. Martin, and Mr. John H. Beach. For any errors of interpretation which may have crept in, however, I alone am responsible.

Funds for the preparation of illustrations have generously been made available by the Research Committee of Stanford University.

Summary of the Stratigraphy of the Kern River Area

When new species of mollusks representing genera not previously recorded in the Pacific Slope Tertiary were detected in samples submitted by Donald C. Birch from collecting localities along Kern River, the potential signficance of the discovery for inter-regional correlation was at once obvious, and further investigation was begun. Detailed maps and sections were prepared by Birch and by Robert T. White which,

[1]An abstract of a portion of this paper has appeared under the title "New *Typhis* from the California Miocene", Bull. Geol. Soc. America, vol. 50, no. 12, pt. 2, December 1, 1939, p. 1972.

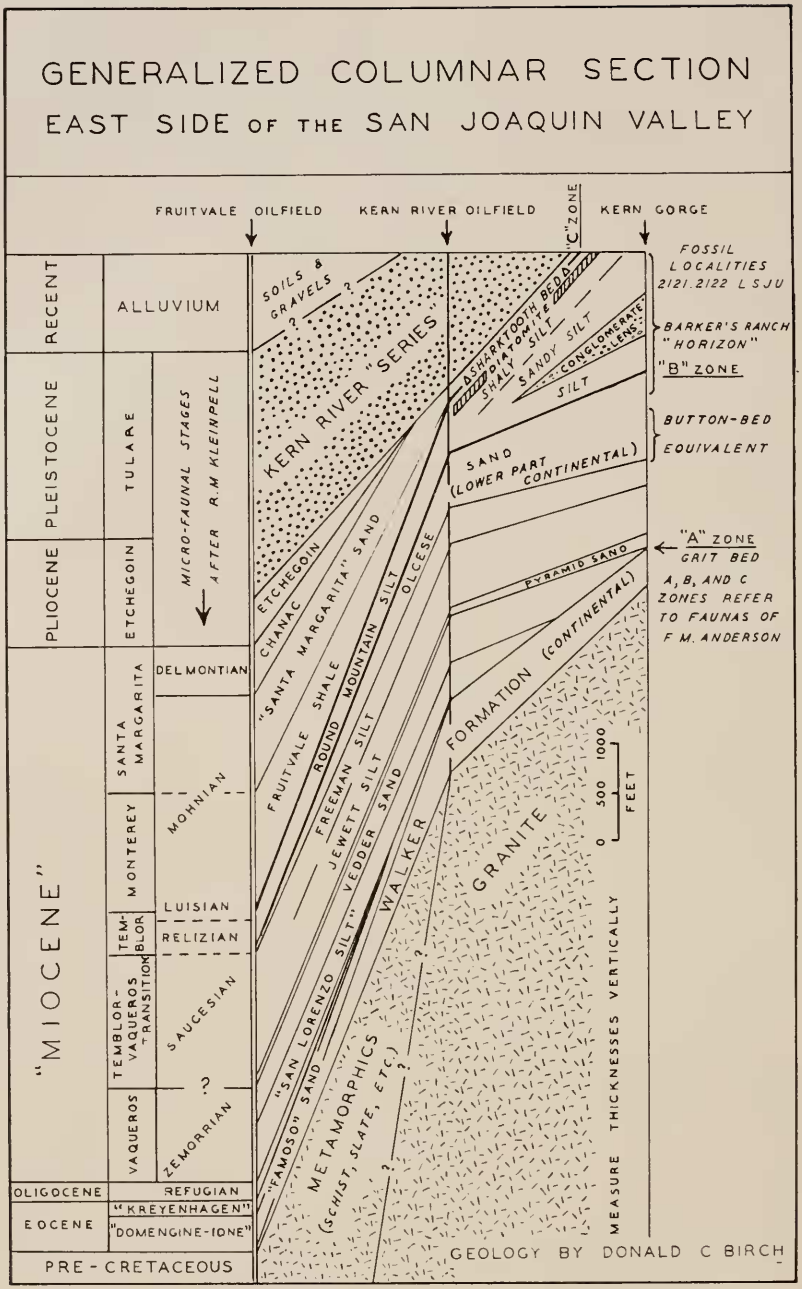

Fig. 2. Columnar sections at three points in the Kern River area.

through their generous cooperation, are published here.

The geology of an area about five miles wide north and south of Kern River, which here flows westward, is shown in figure 1. This region is about twelve miles northeast of Bakersfield, Kern County, California, and is included in the northwest corner of Caliente Quadrangle (U. S. Geol. Survey Topographic sheet). Fossils occur at a number of localities, the three most important of which, for the present study, are Sharktooth Hill, at the upper left of the figure; the classic "Barker's Ranch" (LSJU loc. 2641) near the center; and LSJU loc. 2121 at the right center. The Round Mountain silt member of the Temblor formation is the principal cartographic unit in the area; less widespread are the Olcese sand and the Freeman-Jewett silt. Additional members of the Temblor underlie the area but outcrop only beyond the borders of this map.

Columnar sections at three points from west to east through the Bakersfield-Kern River district, in figure 2, show the relationships and relative thicknesses of all members and formations in the region. Age-assignments shown at the left represent what might be called the standard classification for California; some revisions are suggested in figure 5. The Barker's Ranch "horizon" of early writers is near the top of the right-hand section in figure 2. It includes the upper part of the Olcese sand and the major part of the Round Mountain silt; LSJU locality no. 2641 is in the sand of the lower part and LSJU loc. 2121 in the sandy silt in the upper part of this "horizon." In stratigraphic order below the Round Mountain are (1) the Olcese sand, (2) the Freeman and Jewett silts, often indistinguishable and grading downward locally into (3) the Pyramid Hill sand or "grit zone." All of these members are considered to form a part of the Temblor formation. The underlying Vedder sand is generally correlated with the Vaqueros formation. Above the Round Mountain silt the Fruitvale shale occurs in some parts of the district. Beds of presumed Santa Margarita age, the "Fruitvale sand" of some workers, overlie the Round Mountain. The complete section shown in this figure is, it must be emphasized, based upon subsurface as well as surface observations. A more extensive review of subsurface structure is given by Ferguson.[2]

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[2]Ferguson, Glenn C., "Correlation of oil field formations on east side San Joaquin Valley", State of California, Division of Mines, Bull. 118, pt. 2, Pre-print, pp. 239-246 1 chart, 2 plates, Aug., 1941.

THE ROUND MOUNTAIN SILT[3]

Figure 3 is a detailed columnar section of a part of the Round Mountain silt at Stanford University locality 2121. Although fossils occur in lenses throughout the section, they are exposed best in bands at three levels. Species of mollusks occurring in some abundance at each of these levels are cited in the column at the right. The longest list is from a collection made by the writer in the siltstone twenty feet above the base of the measured section. A mineralogical analysis of the silt, made by Konrad Krauskopf, is summarized in the column "Lithology." Krauskopf comments, further:

> The heavy mineral assemblage is notable for its limited variety, for the scarcity of magnetite, and for the relative abundance of a peculiar type of sphene. The light mineral assemblage is notable for the abundance of clear, unaltered glass and for the relative scarcity of quartz. For so fine a rock the sorting is surprisingly good. The glass fragments are angular and irregularly shaped, but in general they do not have the shard-like form of tuffs. . . . The limited variety and the abundance of such easily altered minerals as hornblende and biotite probably imply that the material has not been carried far from its source.

Altogether, specimens of some 77 species of mollusks were found at the single locality LSJU no. 2121. Compared with Miocene faunules elsewhere, such at the Bowden fauna (Jamaica) or the Alum Bluff (Florida) where 700 to 800 species have been recorded, this may seem an unimpressive number. For the Miocene of California, however, it represents unusual abundance. Preservation of the material and the relative wealth of small forms are particularly noteworthy.

To extract the more minute specimens from the loosely-consolidated silt, an adaptation of micropaleontologic technique was used. A block of matrix was brought to the laboratory, where it was gently crumbled by hand. Larger specimens, as they appeared, were removed with forceps or needles. The remaining fragmentary material was then sifted, dry, in a 16-mesh screen, through which the small shells passed without injury; no water was used in screening, for moisture disintegrated the chalky shell-material. Fragile specimens were coated with a dilute solution of

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[3]The name "Round Mountain silt" (as also "Olcese sand") was proposed by Alex. Diepenbrock, "Mt. Poso oil field", California Oil Fields, vol. 19, no. 2, 1933, p. 14, pl. 2. The type locality is at the west edge of the Mt. Poso oil field, northeast of Bakersfield, Kern Co., in Ohio Oil Co. well no. "Glide" 1, sec. 13, T. 27 S., R. 27 E. If this locality cannot be considered fixed as type locality by monotypy it may be regarded as here designated.

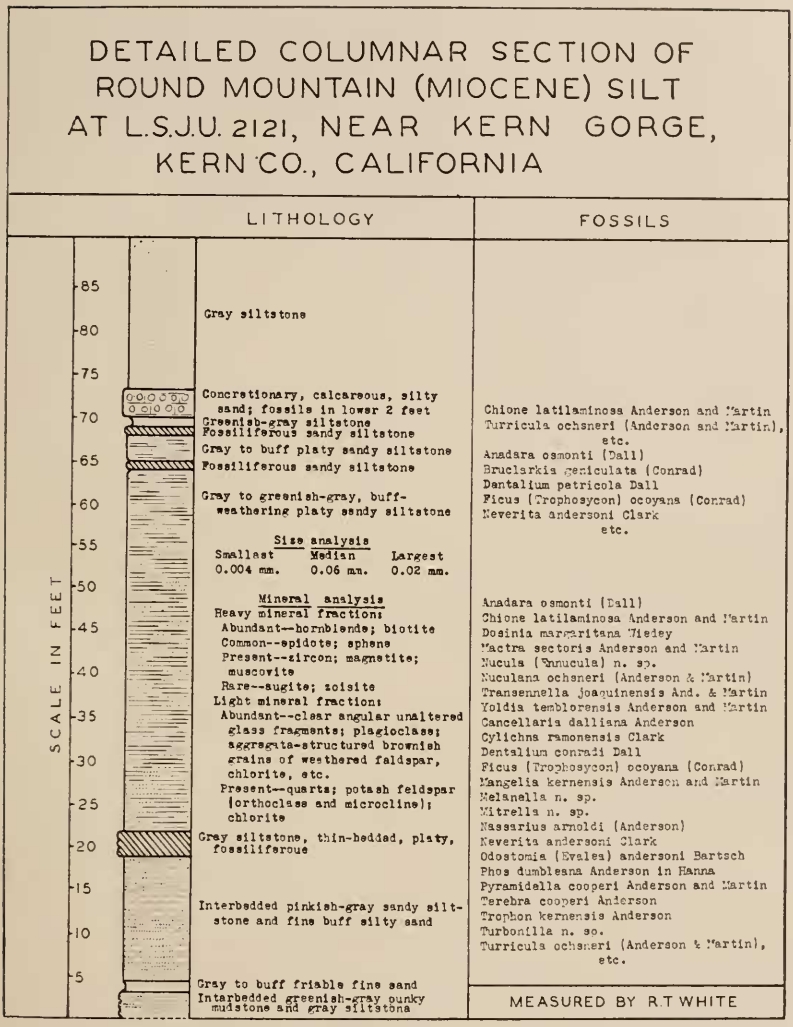

Fig. 3. Analysis of the Round Mountain silt at Stanford University locality 2121.

gum arabic. To avoid the possibility of later recrystallization of the gum, with consequent breakage of type specimens, the gum arabic was removed from all specimens selected for illustration and was replaced either with a dilute solution of cellulose acetate in acetone or with bakelite varnish.

Paleontological Relationships

The genera of mollusks present in the Round Mountain silt are tropical American, such an assemblage as may be found at almost any collecting station off either the West or the East Coast of Central America or in fossil deposits in those regions from Miocene time onward. One gastropod is especially noteworthy in lending added emphasis to

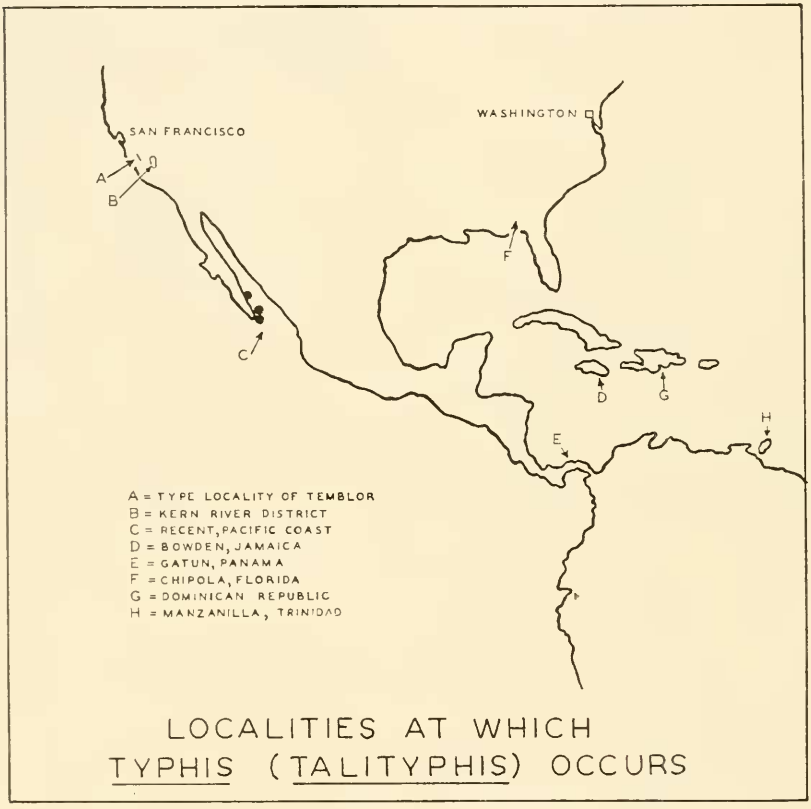

Fig. 4. Localities of occurence of the subgenus *Talityphis*.

the accepted hypothesis that a marine connection existed during the Miocene between the California coast and the Gulf of Mexico. This, a new species, is a member of a genus, *Typhis,* which is geographically well-distributed but, paradoxically, seldom-encountered; the species can be allocated further to the subgenus *Talityphis,* also of rare occurrence, which is restricted geographically to the tropical American region.

Distribution records of the subgenus *Talityphis,* as culled from the literature and as observed in several museum collections in the United States, are plotted in figure 4. *Talityphis* is represented in the Recent fauna by two species; in the Panamic marine faunal province, as shown by the letter "C", localities of collection fall in a limited area near the tip of Lower California; although the subgenus has been considered extinct in the Caribbean, specimens collected among beach sand by A. A. Olsson at Monte Cristi, San Domingo, confirm the existence of the genotype species in the Recent fauna of the Antillean area. The species *T. alatus* Sowerby and the variety *T. alatus obesus* Gabb were established at several localities there during the Tertiary. The earliest record for the subgenus is in the Chipola formation (usually considered early Miocene) of Florida. A second species, *T.* (*T.*) *pterinus* Gardner, occurred also in Florida, in the late Miocene Shoal River formation. *T. alatus* and *obesus* have been reported from the Bowden—"D" of fig. 4—(middle Miocene) of Jamaica; from the Miocene of the Dominican Republic, i.e., Santo Domingo (without stratigraphic allocation)—"G"; from the Gatun (middle Miocene) at Toro Cay, Panama—"E"; and from the Manzanilla (middle Miocene) of Trinidad—"H". The first recognition of the subgenus in the Tertiary of the Pacific Slope of North America is now reported.

In the Recent fauna *Typhis,* sensu lato, is restricted to the neritic zone, at depths of from 6 to 60 fathoms. The related genus *Siphonochelus* has been reported from depths to 400 fathoms. Dredging records for the subgenus *Talityphis* range from 20 to 40 fathoms. Finding it in a fine-grained well-sorted sandstone or silt, as in the Round Mountain occurrence, would indicate that the deposit was laid down some distance off shore in a warm-temperate or tropical sea.

Other genera represented at LSJU loc. 2121, although not as restricted in geographic or bathymetric distribution, lend plausibility to the conclusion that this is a shallow to moderately deep-water subtropical assemblage, closely related to Caribbean and Panamic Miocene and Recent faunules.

AGE AND CORRELATIONS

Figure 5 is a chart to show the stratigraphic and age relationships of those formations in which *Talityphis* has been recorded and their presumed correlation with formations in the Kern River area. Data for

the Antillean-Caribbean region are from Senn[4], with modifications.

Most of the genera present in the Round Mountain silt range through the Tertiary; hence, their appearance here, even if new to California, cannot be used as paleontological evidence of age. Only two generic units may be said, with some degree of certainty, to have originated in the Miocene strata of the tropical American region. *Talityphis,* according to the literature, makes its first appearance in the

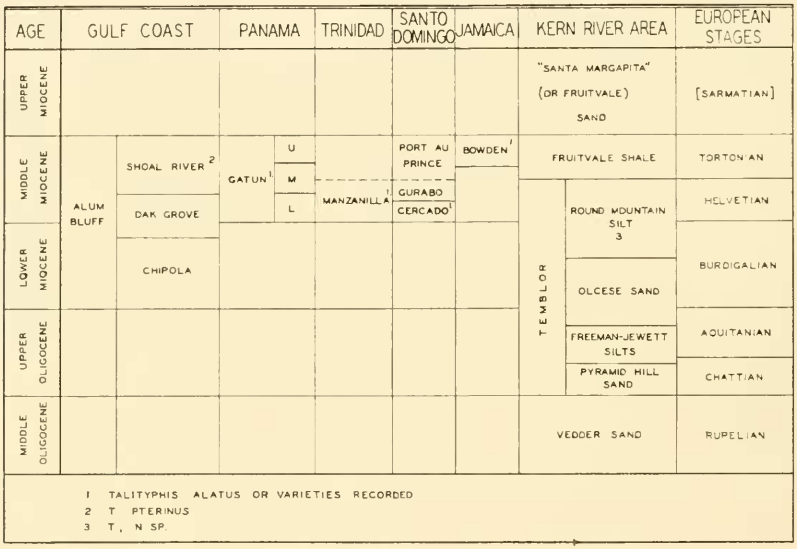

Fig. 5. Tentative correlation of certain Antillean-Caribbean formations with members of the Temblor formation in the Kern River, California, area.

Chipola (lower Miocene) of Florida[5], which may, therefore, be a correlative of the Round Mountain silt. The new subgenus *Temblornia* is, so far as can be ascertained, represented by two species only, one in the Round Mountain silt and one, undescribed, in the basal beds of the lower Gatun. The Round Mountain silt would appear, on the basis of this molluscan evidence, to fall somewhere between the Gatun and the

[4]Senn, A. "Paleogene of Barbados and its bearing on history and structure of Antillean-Caribbean region", American Assoc. Petrol. Geol., Bull., vol. 24, 1940, pp. 1548-1610, 4 text figs., chart.

[5]An undescribed species from Colombia, collected in strata of possible Oligocene age, may be a candidate for allocation to *Talityphis.*

Chipola, as shown in figure 5.[6]

Correlation of either the Caribbean or the Californian basins of deposition with the standard European section must as yet be by indirect evidence. The compilation by Senn (figure 5) attributes Burdigalian age to the Chipola formation, Helvetian to the lower Gatun and correlatives, and Tortonian to the Bowden. Evidence against Tortonian age for the Round Mountain silt is to be found in the occurrence of a fossil sperm whale, *Aulophyseter morricei* Kellogg,[7] in the beds at Sharktooth Hill. This whale Kellogg considers comparable to those in the Helvetian of Europe. As the Sharktooth Hill beds are at the very top of the Round Mountain silt, the Round Mountain cannot be Tortonian; the fact that this vertebrate fossil occurs in the uppermost strata would argue, rather, in agreement with other evidence cited, that the Round Mountain is equivalent to or older than the Helvetian. There remains a possibility that it is Burdigalian and, even more, that the 1,600 feet of fossiliferous strata of the Temblor formation below the Round Mountain silt member are Burdigalian or older. The provisional correlation of these Temblor members and of subjacent and superjacent beds in the Kern River district, as derived from a study of the contained molluscan fauna is, then, shown in figure 5. An attempt to harmonize this correlation with those derived from studies of other phyla, such as Foraminifera, is beyond the scope of this report.

[6]For a summary of foraminiferal evidence of age, which is not altogether in accord with the correlations suggested here, the reader should consult R. M. Kleinpell's "Miocene Stratigraphy of California" (American Assoc. Petrol. Geol.: Tulsa, Okla., 1938, 450 pp., 10 figs., 19 tables, 22 plates). Kleinpell would allocate the Round Mountain silt to the upper part of his Saucesian microfaunal Stage. The Saucesian, according to Schenck (oral communication), is considered to be of Oligocene age. A correlation chart showing relationships of certain microfaunal Stages of California to European Stages and to Antillean-Caribbean formations is given on p. 14 of Schenck, H. G., and T. S. Childs, Jr., "Significance of *Lepidocyclina (Lepidocyclina) californica,* new species, in the Vaqueros formation (Tertiary), California", Stanford Univ. Publ. Univ. Ser., Geol. Sci., vol. 3, no. 2, July 7, 1942, 59 pp., 4 pls.).

[7]Kellogg, Remington, "Study of the skull of a fossil sperm-whale from the Temblor Miocene of southern California", Carnegie Inst. of Washington, Publ. no. 346, 1927, pp. 1-23, pls. 1-9.

Molluscan Species Collected at Stanford University Loc. 2121

A=Abundant (more than 50 specimens)
C=Common (25 to 50 specimens)
I=Infrequent (5 to 25 specimens)
R=Rare (5 specimens or less)

Pelecypoda

Aequipecten andersoni barkerianus? (Arnold) C
Anadara osmonti (Dall) C
Bornia (Temblornia) triangulata (Anderson and Martin) I
Chione (Lirophora) latilaminosa Anderson and Martin C
Chione (Chione) temblorensis (Anderson) C
Donax n. sp. ..... R
Dosinia (Dosinidia) margaritana Wiedey C
Lucinisca menuda n. sp. ..... R
Macoma (Rexithaerus) copelandi Wiedey I
Mactra sectoris Anderson and Martin C
Miltha sanctaecrucis (Arnold) I
Nucula (Ennucula) birchi n. sp. C
Nuculana ochsneri (Anderson and Martin) C
Pandora (Kennerlyia) acutirostrata Clark ..... R
Taras buwaldana (Anderson and Martin) ..... R
Tellina sp. cf. T. arctata Conrad I
Tellina (Arcopagia) ocoyana Conrad I
Tellina (Peronidia) oldroydi Wiedey I
Tellina wilsoni Anderson and Martin I
Transennella joaquinensis Anderson and Martin ..... A
Yoldia oregona Shumard I
Yoldia temblorensis Anderson and Martin ..... A

Gastropoda

Acteon boulderana Etherington I
"Amphissa" posunculensis Anderson and Martin ..... R
Anachis watsonae n. sp. ..... R
Balcis conchita n. sp. C
Bruclarkia geniculata (Conrad) I
Bulla cantuaensis Anderson and Martin ..... R
Calliostoma cf. C. diabloensis Clark ..... R
Calyptraea filosa Gabb I
Cancellaria barkeri (Anderson in Hanna) I
Cancellaria condoni Anderson ..... R
Cancellaria dalliana Anderson ..... A
Cancellaria pacifica Anderson I
Cancellaria ramonensis Clark ..... R
Cancellaria simplex Anderson ..... R
Chrysallida rotundomontana n. sp. ..... R

Conus owenianus Anderson.....A
Crepidula rostralis Conrad.....R
Cylichna (?) loismartinae n. sp.....A
Cylichna temblorensis n. sp.....R
Epitonium cf. E. indianorum (Carpenter).....I
Eulima gabbiana (Anderson and Martin).....R
Ferminoscala durhami n. sp.....I
Ferminoscala whitei n. sp.....R
Ficus (Trophosycon) ocoyana (Conrad).....C
Hastula gnomon n. sp.....I
Mangelia kernensis (Anderson and Martin).....A
Megasurcula howei Hanna and Hertlein.....I
Mitrella (Mitrella) anchuela n. sp.....I
Moniliopsis electilis n. sp.....R
Nassarius antiselli (Anderson and Martin).....R
Nassarius arnoldi (Anderson).....A
Nassarius blakei (Anderson and Martin).....R
Nassarius ocoyanus (Anderson and Martin).....R
Natica posuncula Hanna and Hertlein.....R
Neverita andersoni Clark.....A
Neverita callosa Gabb.....I
Odostomia (Evalea) andersoni Bartsch.....I
Olivella ischnon n. sp.....R
Phos (Antillophos) dumbleana Anderson in Hanna.....I
Pyramidella cooperi Anderson and Martin.....A
Sinum scopulosum (Conrad).....R
Syrnola scandix n. sp.....R
Teinostoma (Teinostoma?) lens n. sp.....R
Terebra cooperi Anderson.....A
Trophon kernensis Anderson.....I
Turbonilla (Pyrgiscus) bravoensis n. sp.....I
Turbonilla (Pyrgolampros) mariposa n. sp.....R
Turricula buwaldana (Anderson and Martin).....R
Turricula ochsneri (Anderson and Martin).....I
Turricula piercei (Arnold).....A
Turritella ocoyana Conrad.....I
Typhis (Talityphis) lampada n. sp.....R
Volvulella gluma n. sp.....R

SCAPHOPODA

Dentalium conradi Dall.....A
Dentalium petricola Dall.....C

Stanford University Collecting Localities

LSJU loc. no. 2121: California, Kern Co., Caliente Quadrangle, near center of southwest quarter of sec. 6, T. 29 S., R. 30 E., Mount Diablo B. L. and M., in small gully close to terrace contact. Stratigraphic horizon: lowermost part of Round Mountain silt. Collectors: Donald C. Birch, 1938; Robert T. White, 1939; Lois T. Martin and Elizabeth A. Watson, 1940; A. Myra Keen, 1939.

LSJU loc. no. 2641: California, Kern Co., Bakersfield or Caliente Quadrangles, in sec. 5, T. 29 S., R. 29 E., M. D. B. and M., 1,000 feet south and 600 feet west of the northeast corner of the section, on the side of a gully, approximately 250 feet north of where a small gully flows onto the alluvium of Kern River. Stratigraphic horizon: basal Round Mountain silt or uppermost Olcese sand.[8] Collector, Robert T. White.

DESCRIPTION OF SPECIES

The paleontological descriptions which follow are arranged alphabetically by genera and species, under the major divisions of "Pelecypoda" and "Gastropoda."

All holotypes are deposited in the Stanford University Paleontological Type Collection. Available paratypes have been distributed to the California Academy of Sciences, the University of California, the United States National Museum, and San Diego Society of Natural History.

Unless otherwise specified, the material was collected by the writer.

PELECYPODA

Genus BORNIA Philippi, 1836

Type (by subsequent designation, Stoliczka, 1870): *Bornia corbuloides* Philippi, 1836.

Subgenus Temblornia Keen, n. subg.

Type: *Donax triangulata* Anderson and Martin, 1914.

Description.—Resembling *Bornia* in outline, with radial sculpture on

[8]Comment by White on this stratigraphic allocation: "Fossils at LSJU loc. 2641 range through a stratigraphic section totalling 120 feet in thickness. This unit is predominantly a fine silty sand and sandy silt which may represent a sandy facies of the lower Round Mountain silt as exposed at Round Mountain. The sand content, on the other hand, might justify interpretation of the unit as the uppermost portion of the Olcese sand."

anterior and posterior slopes; differing from *Bornia*, sensu stricto, in the structure of the hinge; resilifer small and shallow, ventral margin of hinge plate entire, not bisected as in *Bornia*, s. s., by the insertion of the resilium; hinge teeth well developed, consisting of two cardinals and a posterior lateral in the left valve, two cardinals in the right.

Discussion.—*Temblornia* is represented by one species in California. An undescribed and closely similar species has been detected in the lower Gatun formation of the Panama Canal Zone. There is a striking resemblance, especially as regards the hinge, between *Temblornia* and the New Zealand Tertiary group *Semeloidea* Bartrum and Powell (genotype, *S. donaciformis* Bartrum and Powell, 1928, Trans. N. Z. Inst., vol. 59, p. 158, pl. 29, figs. 49-50). In *Semeloidea*, however, the lower margin of the hinge plate is angulate, not smoothly arched; the posterior lateral tooth of the left valve is longer and heavier, and the posterior cardinal is more curved; exteriorly, the radial corrugations are fewer and markedly heavier. Finlay has suggested (Trans. N. Z. Inst., vol. 61, 1930, p. 255) that *Semeloidea*, which was proposed as a genus of the Semelidae, should be regarded as a subgenus of *Bornia*. Thus it is apparently coordinate in rank with *Temblornia*. A revision of the numerous taxonomic units of the Erycinidae is much needed.

Bornia (Temblornia) triangulata (Anderson and Martin), 1914

Donax triangulata Anderson and Martin. Proc. Calif. Acad. Sci., ser. 4, vol. 4, p. 63, pl. 3, fig. 9.

Plate 3, figs. 6, 7

Discussion.—Examination of the holotype (California Academy of Sciences Paleo. Type Coll. no. 130) shows that this is not a *Donax*, but rather a representative of a new subgenus of *Bornia* in which the hinge is strongly developed. The shell is of shining porcellaneous texture with six to eight faintly incised grooves at the anterior and posterior ends. The grooves crenulate the inner margin slightly.

Hypotypes.—Stanford Univ. Paleo. Type Coll. nos. 7523, 7523-a.

Dimensions.—No. 7523, height 4.3, length 6.5 mm.

GENUS DONAX Linnaeus, 1758

Type (by subsequent designation, Schumacher, 1817): *Donax rugosa* Linnaeus, 1758.

Donax n. sp.
Plate 3, fig. 8

Although the species assigned by Anderson and Martin to *Donax* turns out to be a *Bornia*, the genus *Donax* is present in the Round Mountain Silt. A single broken specimen was obtained which is illustrated here. It is too fragmentary to warrant bestowal of a specific name.

Hypotype.—LSJU Paleo. Type Coll. no. 7524, from LSJU loc. 2121.

Dimensions.—Height (incomplete) 3.6, length (incomplete) 5.5 mm.

GENUS DOSINIA Scopoli, 1777

Type (by subsequent designation, Herrmannsenn, 1847): *Chama dosin* Adanson, 1757, =*Artemis africana* Hanley, 1843, ?=*Arthemis africana* Gray, 1838.

Subgenus DOSINIDIA Dall, 1902

Type (by original designation): *Venus concentrica* Born, 1778.

Dosinia (Dosinidia) margaritana Wiedey, 1928

Trans. San Diego Soc. Nat. Hist., vol. 5, no. 10, p. 145, pl. 18, figs. 1-3. Type locality: Near La Panza, eastern San Luis Obispo Co., California; Vaqueros formation.

Plate 3, figs. 3-5

So abundant are young specimens of *Dosinia margaritana* in the Round Mountain silt that they might easily be mistaken for adults of some minute pelecypod. At the same horizon occur adult *Dosinia* with well-preserved beaks which, by their outline and the spacing of concentric sculpture, leave no room for doubt of the identity of the small shells. As compared with the adult, the juvenile *Dosinia* has a much less massive hinge plate; the hinge teeth are relatively more widely spaced and the anterior cardinal and lateral teeth more conspicuous.

Hypotypes.—LSJU nos. 7525, 7525-a, 7525-b, from LSJU loc. 2121.

Dimensions.—No. 7525, height 3.6, length 3.8 mm.; nos. 7525-a, 7525-b, height 2.5, length 2.7 mm.

GENUS LUCINISCA Dall, 1901

Type (by original designation): *Lucina nassula* Conrad, 1846.

Lucinisca menuda Keen, n. sp.

Plate 3, figs. 15, 16

Shell small, nearly circular in outline; sculpture of radial and concentric riblets which intersect as beads, more closely spaced on posterior slope than on central and anterior parts of shell (somewhat obscured in holotype by an incrustation of sand grains which could not be removed); beaks nearly central, dorsal margin sloping downward at a low angle; posterior margin somewhat truncate, joining dorsal at an angle of about fifty degrees; ventral and anterior margins evenly rounded; margins crenulated by the ends of the radial ribs; muscle scars subequal, pallial line entire; hinge of left valve strong, with two anterior lateral teeth, two subequal cardinal teeth, and a double posterior lateral tooth or clasper; right valve not available.

Holotype.—A left valve, Stanford Univ. Paleo. Type Coll. no. 7526, collected by R. T. White from LSJU loc. 2121.

Dimensions.—Height 6.7, length 6.5 mm.

Discussion.—From the West American Recent species *Lucinisca nuttalli* (Conrad) this is distinguished by the truncate posterior margin and the more

attenuate anterior margin. Possibly *L. menuda* may be the *Lucinisca* aff. *L. nuttalli* (Conrad) recorded by Loel and Corey (Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 22 ,1932, p. 210); attempts to locate the specimens mentioned by Loel and Corey have not been successful.

Several species of *Lucinisca* are reported in the Chipola and Bowden formations of the Caribbean area.

The species name *menuda* is from the Spanish, meaning "minute."

GENUS NUCULA Lamarck, 1799

Type (by monotypy): *Arca nucleus* Linnaeus, 1758.

Subgenus ENNUCULA Iredale, 1931

Type (by original designation): *Nucula obliqua* Lamarck, 1819.

Nucula (Ennucula) birchi Keen, n. sp.

Nucula (Ennucula) n. sp. Schenck and Keen, 1940. Calif. Fossils for the Field Geologist, p. 10, pl. 4, figs. 6-7.

Plate 3, figs. 9-12

Shell small, solid, ovate, beaks low, opisthogyrate; lunule and escutcheon not marked; sculpture of incremental lines only; posterior end truncate, anterior produced and rounded, base arched; interior nacreous, adductor and auxiliary muscular impressions present, faint (not shown in figures), basal margin smooth; hinge strong, chondrophore oblique, anterior teeth 15, posterior 6.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7527; paratypes nos. 7527-a, 7527-b; hypotype (specimen figured by Schenck and Keen) no. 7320.

Dimensions.—Holotype, length 6.5, height 5.2, semi-thickness 1.5 mm.; paratype 7527-a, length 6.9, height 5.2; paratype 7527-b, length 7.0, height 5.0, thickness 3.0 mm.

Discussion.—From the only other described West American Miocene *Nucula, N. washingtonensis* Weaver (Univ. Washington Publ. Geol., vol. 1, no. 1. 1916, p. 34, pl. 3, figs. 27-29), this is distinguished by its smaller diameter, its more ovate outline, and its lack of impressed "lunule" (i.e., escutcheon). *Nucula postangulata* Clark (Univ. Calif. Publ. Bull. Dept. Geol., vol. 11, 1918, p. 122, pl. 13, figs. 2, 5) of the Oligocene San Ramon formation, California, is less attenuated anteriorly and has an impressed escutcheon, according to the original description. From *Nucula taphria* Dall (Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, 1898, p. 576, pl. 32, fig. 14) of the Florida Miocene *N. birchi* differs by its smoother exterior and its low beaks.

Named in honor of Donald C. Birch, whose careful collecting and mapping paved the way for the present study.

GENUS TRANSENNELLA Dall, 1883

Type (by monotypy): *Cytherea (Transennella) conradina* Dall, 1883.

Transennella joaquinensis Anderson and Martin, 1914

Proc. Calif. Acad. Sci., ser. 4, vol. 4, p. 60, pl. 3, figs. 6 a-c.

Plate 3, figs. 1, 2

Interiors of two specimens are figured here to show the hinge, inadequately

illustrated by Anderson and Martin.

In common with most West American species assigned to *Transennella,* the interior shell margin does not exhibit the striations characteristic of the genotype, which is from the Recent fauna of Florida. Woodring[9] suggests that some or all West American species should be excluded from *Transennella.* Research to settle this point is beyond the scope of the present paper; such material in the Stanford University collection as has been scrutinized does not entirely confirm Woodring's observation. For the time being, therefore, *joaquinensis* is retained in *Transennella.*

Hypotypes.—Stanford Univ. Paleo. Type Coll. nos. 7528, 7528-a.

Dimensions.—No. 7528, height 4.9, length 5.5; no. 7528-a, height 3.1, length 3.5 mm.

GASTROPODA

Genus ACTEON Montfort, 1810

Type (by monotypy): *Acteon tornatilis* (Gmelin)=*Bulla tornatilis* Linnaeus, 1758.

Acteon boulderana Etherington, 1931

Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 20, no. 5, p. 113, pl. 14, fig. 9. From the Astoria (Miocene) of south-west Washington.

Plate 4, fig. 22

Hypotype.—Stanford Univ. Paleo. Type Coll. no. 7529, from LSJU loc. 2641, R. T. White collector.

Dimensions.—Height 18.0, diameter 9.3 mm.

Discussion.—Although Etherington cited specimens of *boulderana* from the Kern River area, no illustrations of California specimens have been published, nor has the occurrence received mention by other authors. To authenticate the record, therefore, a figure is included here.

Genus ANACHIS H. and A. Adams, 1853

Type (by subsequent designation, Tate in Woodward, 1875): *Columbella scalarina* Sowerby, 1832.

Anachis watsonae Keen, n. sp.

Plate 4, figs. 1, 2

Shell moderately small and stout, whorls of spire almost flat; anterior canal short, pillar wide; inner lip smooth, outer lip broken in only specimen available; sculpture apparently of axial ribs only on spire (8 ribs on antepenultimate whorl in holotype); body whorl smooth, with 8 incised spiral grooves on pillar and base.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7530, from LSJU loc. 2121.

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[9]In Woodring, W. P., R. Stewart, and R. W. Richards, "The geology of the Kettleman Hills oil field, California," U. S. Geol. Survey Prof. Paper 195, "1940" (published in 1941), p. 95.

Dimensions.—Height 9.7, diameter, 4.3 mm.

Discussion.—Only one broken specimen is available. On this the cortical layer is lacking on the spire; however, the persistent axial ribs and the general outline of the shell make the diagnosis as a new species of *Anachis* plausible. No closely similar species appears in the literature on the Miocene of the Caribbean area or in the California Tertiary record. Numerous species of *Anachis* have been described from the Panamic marine province.

Named for Miss Elizabeth Watson, in appreciation of assistance in collecting material from the Round Mountain silt.

GENUS BALCIS Leach in Gray, 1847

Type (by monotypy): *Balcis montagui* Leach in Gray=*Strombiformis albus* Da Costa, 1778.

Balcis conchita Keen, n. sp.
Plate 4, fig. 5

Shell elongate-conic, slender, straight, whorls flattened, appressed at the summits; periphery of the last whorl rounded, base long, well rounded; aperture large, oval; posterior angle acute; outer lip rounded; inner lip short, stout, somewhat curved, reflected and appressed to the base; parietal wall covered with a callus.

Holotype.—Stanford Univ. Paleo. Type Coll. no 7538, from LSJU loc. 2121.

Dimensions.—Height 6.4 (estimated), diameter 1.5, height of aperture 1.3 mm.

Discussion.—The nearest Recent West American relative of this species is *Balcis rutila* (Carpenter) (Suppl. Rept., British Assoc. Adv. Sci. for 1863, 1864, p. 659, figured, as *Melanella*, by Bartsch (Proc. U. S. Nat. Mus., vol. 53, 1917, pl. 35, figs. 2, 3, 6), which is slightly larger and proportionately wider. None of the Caribbean species in the literature seems to be close to *B. conchita.*

Winckworth (Jour. Conch., vol. 20, no. 1, May, 1934, pp. 12-13) has shown that the name *Melanella* is of doubtful validity, as the genotype is virtually unidentifiable. The next available synonym is *Balcis*, which is here tentatively accepted.

The specific name *conchita* is derived from the Spanish word for "little shell."

GENUS CHRYSALLIDA Carpenter, 1856

Type (by subsequent designation, Dall & Bartsch, 1904): *Chrysallida communis* Carpenter, 1856, (not C. B. Adams, 1852) = *Odostomia (Chrysallida) torrita* Dall and Bartsch, 1909.

Chrysallida rotundomontana Keen, n. sp.
Plate 4, fig. 28

Shell small, ovate-conic; nuclear whorls not preserved on holotype; postnuclear whorls flattened, strongly contracted at sutures and slightly shouldered

at summits, marked by about 16 curved axial ribs which cross four strong spiral cords with nodose intersections; periphery of last whorl marked by a spiral cord not crossed by axial sculpture; base nearly smooth, with about 8 shallow spiral grooves which become fainter toward columella; aperture oval, posterior angle acute; columella stout, reflected anteriorly, with a strong fold at its insertion.

Holotype.—LSJU Paleo. Type Coll. no. 7531, from LSJU loc. 2121.

Dimensions.—Height 2.8, diameter 1.4 mm.

Discussion.—In the Recent fauna of the West Coast *Odostomia (Chrysallida) pulcia* Dall and Bartsch, 1909, is the closest relative. It is slightly smaller than *C. rotundomontana*, with more numerous axial ribs. From *Odostomia (Chrysallida) melanoides* (Conrad) as figured by Martin, 1904, Maryland Geol. Survey, Miocene, p. 220, pl. 54, fig. 1, *C. rotundomontana* differs in being smaller, proportionately broader, and less conspicuously sculptured on the base.

The name *rotundomontana* is the Latinization of "Round Mountain."

GENUS CYLICHNA Loven, 1846

Type (by subsequent designation, Herrmannsenn, 1852): *Bulla cylindracea* Pennant, 1777.

Cylichna? loismartinae Keen, n. sp.

Plate 4, figs. 16, 18

Shell small, cylindrical, posterior end rounded; spire concealed, apex slightly depressed and bounded by a low ridge; aperture as long as shell, anterior end dilated, posterior end narrowed toward apex; columella with a low, oblique basal fold; sculpture of faint incised grooves, more apparent at anterior end, and incremental lines.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7532, from LSJU loc. 2121.

Dimensions.—Height 3.4, diameter 1.8 mm.

Discussion.—From *Cylichna temblorensis* this species is readily separable by its greater width, its smaller size, and its posteriorly narrowed aperture. At first glance the outline would suggest *Cylichnella*, but all six specimens available lacked the second columellar fold of that genus. The species is therefore tentatively allocated to *Cylichna* until such time as a revision of the Scaphandridae makes possible a more precise assignment. No other Miocene or Recent species in the Caribbean or West American area seem comparable.

Named in honor of Miss Lois T. Martin, who assisted in collecting material from the Round Mountain silt.

Cylichna temblorensis Keen, n. sp.

Plate 4, figs. 13, 14

Shell small, cylindrical, posterior end truncated; spire immersed, apex concave; aperture as long as shell, anterior end dilated, posterior end somewhat elevated above remainder of body whorl; columella bearing an obscure, oblique

basal fold; sculpture of occasional faint grooves and incremental lines.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7533, from LSJU loc. 2121.

Dimensions.—Height 4.0, diameter 1.6 mm.

Discussion.—From *Cylichna ramonensis* Clark, 1918 (Univ. Calif. Publ. Bull. Dept. Geol., vol. 11, p. 188, pl. 20, fig. 7) this species is distinguished by its smaller size and more truncate posterior end; from *C. aula* Woodring of the Bowden Miocene (Carnegie Inst. Publ. 385, 1928, p. 129, pl. 2, fig. 19) by its greater height and the lack of a grove at the apex. From all Chipola (Florida, Miocene) species *temblorensis* is distinguished by its proportionately greater height and the shallower umbilical groove, and from the West American Recent "*C. alba* Brown" of authors it is distinguished by its consistently smaller size and its almost complete absence of spiral sculpture.

GENUS EULIMA Risso, 1826

Type (by subsequent designation, Herrmannsenn, 1846): *Turbo subulatus* Donovan=*Strombiformis glaber* Da Costa, 1778.

Eulima gabbiana (Anderson and Martin)

Eulimella gabbiana Anderson and Martin, 1914. Proc. Calif. Acad. Sci., ser. 4, vol. 4, p. 68, pl. 7, fig. 20. Near Barker's Ranch, Kern Co., Miocene.
Plate 4, fig. 6

Hypotype.—Stanford Univ. Paleo. Type Coll. no. 7543, from LSJU loc. 2641, collected by R. T. White.

Dimensions.—Height 9.5, diameter 1.9, height of aperture 2.3 mm.

Discussion.—This species was, on the basis of the original figure, allocated to *Melanella* by Bartsch, 1917 (Proc. U. S. Nat. Mus., vol. 53, p. 316). Study of the incomplete holotype (Calif. Acad. Sci. Paleo. Type Coll. no. 143), a specimen with only the last 2½ whorls, and comparison with material from the type locality show this to be an *Eulima*[10]. This genus is distinguished from *Melanella* of authors (*Balcis* Leach of this paper), by the attenuated outline and narrow, elongate aperture. A virtually complete specimen from the type locality is figured here.

No Recent West American species of *Eulima* approaches *E. gabbiana* closely in size and proportions; the nearest is *E. californica* (Bartsch) (Proc. U. S. Nat. Mus., vol. 53, 1917, p. 340, pl. 45, fig. 5) which, however, is larger and proportionately more slender. *E. migrans* Conrad, 1846, as figured by Martin, 1904 (Maryland Geol. Survey, Miocene, p. 217, pl. 53, fig. 12), from the St. Mary's Miocene of Maryland is, if Martin's dimensions are correct, considerably more slender. Martin's illustration shows a wider, shorter shell, with a wider aperture and a more impressed suture.

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[10]"*Strombiformis*" of authors, not of Da Costa as designated by Harris, 1894. For a discussion of nomenclature in this family, see Winckworth, Jour. of Conch., vol. 20, no. 1, May, 1934, pp. 12-13.

Genus FERMINOSCALA Dall, 1908

Type (by original designation): *Epitonium (Ferminoscala) ferminianum* Dall, 1908.

Ferminoscala durhami Keen, n. sp.

Plate 4, fig. 31

Shell small, conical, whorls rounded, sutures impressed; sculpture of six raised spiral threads about equally spaced, crossed by weak axial threads more apparent on spire than on later whorls; aperture round, inner lip reflected, outer lip broken on both specimens observed, probably thin; basal disk with spiral threads only.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7534, from LSJU loc. 2121.

Dimensions.—Height (incomplete) 8.7, diameter 3.0 mm.

Discussion.—Compared with *F. whitei*, described below, this shell has a wider apical angle and lacks the heavy axial sculpture. It corresponds to *F. pseudoleroyi* (Maury) (Bulletins of Amer. Paleo., vol. 10, no. 42, 1925, p. 394) from Jamaica, whereas *F. whitei* corresponds to *F. spathe* Woodring. From *F. pseudoleroyi* it differs in the greater apical angle and in the narrowness of its spiral ribs. It resembles *F. prunicola* (Martin) (Maryland Geol. Survey, Miocene, 1904, p. 214, pl. 53, fig. 6) but has fewer and weaker spiral ribs.

As Woodring remarks (Carnegie Inst. Publ. 385, 1928, p. 402), "There is no reason to suppose that *Ferminoscala* bears any direct relation to *Acrilla* H. and A. Adams", under which it is often subsumed.

This species is named for Dr. J. Wyatt Durham in recognition of his his work upon West American Tertiary Epitoniidae.

Ferminoscala whitei Keen, n. sp.

Plate 4, figs. 32, 33

Shell of medium size, slender, with eight whorls sculptured with about 25 to 30 retractive axial lamellae per whorl and 6 high spiral threads, producing deep rectangular pits; in addition with microscopic axial and spiral sculpture, especially in pits; sutures impressed, somewhat channeled; basal disk with four spiral threads; basal lip bent backward, forming a narrow and obscure fasciole.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7535, from LSJU loc. 2121, collected by R. T. White.

Dimensions.—Height 15.5, diameter 6, height of aperture 4.6 mm.

Discussion.—This species is similar to *F. spathe* Woodring (Carnegie Inst. Publ. 385, 1928, p. 403, pl. 32, fig. 5) from the Bowden and to *F. reticulata* (Martin), 1904 (Maryland Geol. Survey, Miocene, p. 214, pl. 53, fig. 5) from the Miocene of Maryland, but is wider, with more impressed sutures than either.

Named for R. T. White, the collector, in appreciation of advice on problems of stratigraphy, preparation of a columnar section of the Round Mountain silt, and collection of specimens.

GENUS HASTULA H. and A. Adams, 1853

Type (by subsequent designation, Cossmann, 1896): *Buccinum strigilatum* Linnaeus, 1758.

Hastula gnomon Keen, n. sp.
Plate 4, fig. 11

Shell of medium size, slender, whorls flat; sculpture of narrow axial ribs which disappear on anterior part of later whorls, numbering (on holotype) 17 to 20 ribs per whorl; surface except for the puckered axial ribbing smooth and shining; outer lip of aperture evidently thin (broken on all specimens examined); parietal wall with a thin callus, columella bearing an obscure basal fold, siphonal fasciole with a faint median groove.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7536, from LSJU loc. 2121, Donald Birch collector.

Dimensions.—Height 17.2, maximum diameter 4.6, height of aperture 4.6 mm.

Discussion.—In the West American Recent fauna *Hastula* is represented in the Panamic area by *Terebra luctuosa* Hinds, 1844 (Proc. Zool. Soc. London for 1843, p. 157), which is larger, with more numerous axial plications. Woodring has reported two species of *Hastula* from the Bowden formation of Jamaica (*H. jamaicensis* Woodring, Carnegie Inst. Publ. 385, 1928, p. 143, pl. 4, fig. 4, and *H. homala* Woodring, ibid., pl. 4, fig. 5). *H. gnomon* resembles the former in size, the latter in outline but has less prominent axial ribs than either. Of the four St. Mary's and Calvert Miocene species described by Martin (Maryland Geol. Surv. Miocene, 1904, pp. 143-144, pl. 40, figs. 10-14), *Terebra (Hastula) patuxentia* is nearest to *gnomon*; its axial sculpture is more closely spaced, however, and the illustration shows spiral striations. No *Hastula* have been reported from lower or middle Miocene deposits in the Caribbean. Therefore, this record in California seems to be the earliest in the Americas. The genus is recorded in the Eocene of Europe.

The word *gnomon* is a Latin noun, masculine gender; a *gnomon* is a pin or pointer on a sun dial.

GENUS MANGELIA Risso, 1826

Type (by subsequent designation, Herrmannsenn, 1852): *Mangelia striolata* Risso=*Murex attenuatus* Montagu, 1803.

Subgenus CACODAPHNELLA Pilsbry and Lowe, 1932

Type (by original designation): *Cacodaphnella delgada* Pilsbry and Lowe, 1932.

Mangelia (Cacodaphnella?) kernensis (Anderson and Martin)

Mangilia kernensis Anderson and Martin, 1914. Proc. Calif. Acad. Sci., ser. 4, vol. 4, p. 94, pl. 7, figs. 6 a-b. Barker's Ranch, Kern Co., Miocene.
Plate 4, fig. 21

Hypotype.—Stanford Univ. Paleo. Type Coll. no. 7537, from LSJU loc. 2121.

Discussion.—The nuclear whorls of *M. kernensis* do not conform to the pattern of any of the numerous genera of small sculptured turrids described by Woodring (Carnegie Inst. Publ. 385, 1928, pp. 165-198). The first two whorls are smooth, the next half-turn with 5 to 7 spiral threads crossed but not cancellated by fine, almost microscopic, axial riblets. In the third or post-nuclear whorl the first sinuous axial ribs appear, puckering the spiral ribs at regular intervals. Axial ribs are more prominent than spiral in later whorls, the spiral ribs crossing over axials as undulating threads. In *Cacodaphnella*, as described by Pilsbry and Lowe (Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 58, 1932), both axial and spiral sculpture appear in the nuclear whorls though never as the heavy cancellations common in other groups of small turrids such as *Cryoturris* Woodring (*op. cit.*, p. 178). Although Pilsbry and Lowe did not observe any other Recent West American species which they could assimilate to *Cacodaphnella*, there seems to be a candidate in *Mangelia densilineata* (Dall) (U. S. Nat. Mus. Bull. 112, p. 83, 1921). *Cacodaphnella* would thus appear to be a turrid group comprised of three species, one Miocene and two Recent, and restricted in distribution to the West Coast of North America.

GENUS MITRELLA Risso, 1826

Type (by subsequent designation, Cox, 1927): *Mitrella flaminea* Risso, 1826 =*Murex scriptus* Linnaeus, 1758.

Mitrella (Mitrella) anchuela Keen, n. sp.
Plate 4, fig. 12

Shell small, stout, pillar constricted; whorls of spire slightly bulging; aperture relatively wide; outer lip thin, set with five heavy denticles within the aperture, attenuated anteriorly and curving into a notch-like narrow canal (broken in holotype during preparation); inner lip smooth, reflected and appressed to body whorl; sculpture of about five coarse threads on the pillar and anterior portion of body whorl.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7539, from LSJU loc. 2121.

Dimensions.—Length 5.1, diameter 2.7 mm.

Discussion.—This is the shortest and stoutest of West American Mitrellas, fossil or living. It is also distinguished from *M. (Striomitrella) tenuilineata* (Clark) (Univ. Calif. Publ. Bull. Dept. Geol., vol. 11, 1918, p. 173, pl. 22, figs. 2, 3) by its scanty spiral sculpture. Caribbean Miocene Mitrellas such as *M. lissa* Woodring (Carnegie Inst. Publ. no. 385, 1928, p. 275, pl. 16, fig. 14) or *M. lepta* Woodring (*ibid.*, pl. 16, fig. 15) from the Bowden or *M. communis* (Conrad) (figured as *Columbella* by Martin, Maryland Geol. Survey, Miocene, 1904, p. 199, pl. 50, figs. 5-7) are larger and more slender, lacking the peculiar elongation of the outer lip.

The specific name *anchuela* is from the Spanish, meaning "somewhat broad."

GENUS MONILIOPSIS Conrad, 1865

Type (by monotypy): *Pleurotoma elaborata* Conrad, 1833.

Moniliopsis electilis Keen, n. sp.
Plate 4, fig. 15

Shell small to medium in size, biconic, aperture less than half the length of the shell; nuclear whorls not preserved on sole specimen obtained; postnuclear whorls rounded, suture impressed; surface cancellately sculptured by axial ribs which bend to the right at the anal fasciole and spiral ribs of equivalent strength, axial ribs 23 on last whorl, more pronounced below anal fasciole, spiral ribs 6 to 8 per whorl, upper 3 ribs weaker than those below anal fasciole; body whorl cancellately sculptured like spire; anal fasciole just above periphery of whorl, marked by bending of axial ribs; pillar narrow, inner lip erased, outer lip thin; aperture rounded above, prolonged into a canal below.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7540, from LSJU loc. 2121, R. T. White collector.

Dimensions.—Height (incomplete) 12.2, diameter 4.8, length of aperture 2.3 mm.

Discussion.—No similar species occurs in the Miocene of West America or the Caribbean area. Comparable Pliocene and Recent species of the West Coast are *Moniliopsis graciosana* (Arnold) (Smithsonian Misc. Coll., vol. 50, pt. 4, 1907, p. 430, pl. 54, fig. 18) from the Careaga formation (Pliocene) of Santa Barbara County, California, which has coarser axial sculpture and is not evenly cancellate, and *M. incisa* (Carpenter) (Suppl. Rept. British Assoc. Adv. Sci. for 1863, pp. 603, 657, 1864), which has spiral sculpture only.

The name *electilis* is a Latin adjective signifying "dainty."

GENUS ODOSTOMIA Fleming, 1817

Type (by subsequent designation, Dall and Bartsch, 1904): *Turbo plicatus* Montagu, 1803.

Subgenus EVALEA A. Adams, 1860

Type (by subsequent designation, Dall and Bartsch, 1904): *Evalea elegans* Adams, 1860.

Odostomia (Evalea) andersoni Bartsch, 1917

Eulimella californica Anderson and Martin, 1914. Proc. Calif. Acad. Sci., ser. 4, vol. 4, p. 67, pl. 7, figs. 19 a-c. Miocene, near Barker's Ranch, Kern Co. (Not *Odostomia (Evalea) californica* Dall and Bartsch, 1909).

Odostomia (Evalea) andersoni Bartsch. Proc. U. S. Nat. Museum, vol. 52, no. 2193, May, 1917, p. 667.

Plate 4, figs. 17, 23

Two specimens of *Odostomia andersoni* are figured here. Fine spiral striae on the surface of the shells, too minute to show in the photographic illustrations, indicate the correctness of the allocation to *Evalea* made by Bartsch.

Hypotypes.—Stanford Univ. Paleo. Type Coll. nos. 7541, 7541-a.

Dimensions.—No. 7541, height 3.0, diameter 1.5; no. 7541-a, height 2.5, diameter 1.4 mm.

Genus OLIVELLA Swainson, 1831

Type (by subsequent designation, Dall, 1909): *Olivella purpurata* Swainson, 1831=*Voluta dama* Wood, 1828.

Olivella ischnon Keen, n. sp.
Plate 4, figs. 3, 4

Shell relatively small and slender; spire high, about three-fourths the length of the aperture; sutural channel deep and wide; columellar folds weak, five in number, near anterior end of inner lip.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7542, from LSJU loc. 2641, R. T. White collector.

Dimensions.—Height 9.4, diameter 4.5 mm.

Discussion.—None of the Caribbean Miocene Olivellas seem to approach this species closely in outline or in relative proportions. In the Recent West American fauna *Olivella pedroana* Conrad (Pacific Railway Survey Reports, vol. 5, 1855, pl. 6, fig. 51) is probably nearest, but it lacks the deeply channeled suture of *ischnon*. From the San Ramon formation (Oligocene) of California Clark has described *O. quadriplicata* (Univ. Calif. Publ. Dept. Geol., vol. 11, 1918, p. 185, pl. 19, figs. 10, 17); this is distinguished from *ischnon* by its four columellar plications and by its lower and wider spire.

The name *ischnon* is a Latin noun, neuter gender, signifying "a slender thing."

Genus SYRNOLA A. Adams, 1860

Type (by monotypy): *Syrnola gracillima* A. Adams, 1860

Syrnola scandix Keen, n. sp.
Plate 4, figs. 24, 29, 30

Shell of medium to small size, elongate-conic; nucleus heterostrophic, axis at right angle to spire, about 1/3 immersed in succeeding whorl; first post-nuclear whorl rounded, later whorls nearly flat; suture deeply impressed, later whorls appressed over sutural channel; sculpture of microscopic growth lines and spiral striations, early whorls with a few incipient axial ribs; aperture oval, outer lip thick in adult shell; columella with a single low fold.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7544; paratypes nos. 7544-a and 7544-b, from LSJU loc. 2121.

Dimensions.— Holotype, height 7.0, diameter 2.1, no. 7544-a, height 3.5, diameter 1.1; no. 7544-b, height 2.3, diameter 0.7 mm.

Discussion.—The genus *Syrnola* has not been reported in the Recent West American fauna, and only one other Pacific Slope Miocene species is known, *Eulimella ochsneri* Anderson and Martin (Proc. Calif. Acad. Sci., ser. 4, vol. 4, 1914, p. 66, pl. 7, figs. 23 a-b) which Bartsch (Proc. U. S. Nat. Mus. vol. 52, 1917, p. 639) correctly allocated to *Syrnola*; this species is larger and much more deeply channeled at the sutures than *scandix*. *Syrnola* is represented in

the Caribbean Tertiary by such species as *S. marylandica* (Martin) (Maryland Geol. Survey, Miocene, 1904(p. 221, pl. 54, fig. 6), which is proportionately shorter with a more quadrate aperture than *scandix*.

Scandix is a Latin noun, feminine gender, meaning "stork's bill."

GENUS TEINOSTOMA H. and A. Adams, 1853

Type (by subsequent designation, Cossmann, 1888): *Teinostoma politum* A. Adams, 1853.

Teinostoma (Teinostoma?) lens Keen, n. sp.
Plate 4, figs. 7-9

Shell small, thin, circular, spire depressed and partially covered by succeeding whorls; outer lip, as viewed from above, arched forward between suture and periphery; basal lip, as viewed from below, arched backward; umbilicus obscured by a thin callus which covers about 1/3 of base and merges with the thin parietal callus; sculpture of incremental lines only.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7545.

Dimensions.—Height 0.7 mm., diameter 1.8 mm.

Discussion.—*Teinostoma lens* is intermediate in characters between the *T. nanum* (Lea) and the *T. calvertense* Martin of the Maryland Miocene, as figured by Martin, 1904, Maryland Geol. Survey, Miocene, pp. 263, 264, pl. 62, figs. 1-2, 3, resp.), being more depressed than the former and having a heavier callus than the latter. It is smaller and more oblique than *T. sublimatum* Dall (Proc. U. S. Nat. Mus., vol. 51, no. 2162, 1916, p. 520, pl. 88, figs. 7, 8) from the Flint River (Georgia) "Oligocene." It is also more depressed than *T. depressum* (Gabb) figured by Pilsbry (Proc. Acad. Nat. Sci. Philadelphia, vol. 73, 1921, pl. 37, fig. 2) from the Miocene of Santo Domingo. In the Recent West American fauna the nearest relative appears to be *T. sapiellum* Dall (Proc. U. S. Nat. Mus., vol. 56, no. 2295, 1919, p. 369), which is a thinner shell with a more convex spire and fewer whorls.

The Latin name *lens* ("lentil"—masculine gender) is chosen in reference to the lenticular shape of the shell.

GENUS TURBONILLA Risso, 1826

Type (by subsequent designation, Dall and Bartsch, 1904): *Turbonilla plicatula* Risso (not Brocchi) = *T. typica* Dall and Bartsch, 1904.

Subgenus PYRGISCUS Philippi, 1841

Type (by subsequent designation, Dall and Bartsch, 1904): *Melania rufa* Philippi, 1836.

Turbonilla (Pyrgiscus) bravoensis Keen, n. sp.
Plate 4, figs. 20, 26, 27

Shell small, elongate-conic; nuclear whorls 2, helicoid, axis at right angles to spire, slightly immersed in succeeding whorl; post-nuclear whorls nearly flat, narrowly tabulate at the summits, ornamented by 14 to 16 sinuous axial ribs

per whorl; intercostal spaces about 1½ times as wide as ribs, crossed by 7 to 8 spiral threads which divide the interspaces into a series of pits; suture impressed, somewhat wavy; periphery of body whorl well rounded, without axial sculpture; base nearly smooth (a few faint spiral grooves present); aperture quadrate, outer lip rounded, columella strong, a little twisted.

Holotype.—LSJU Paleo. Type Coll. no. 7546; paratype, no 7546-a.

Dimensions.—Holotype, height (incomplete) 4.1, diameter 1.3 mm.; paratype no. 7546-a, height (incomplete) 3.0, diameter 1.0; no. 7546-b, height 1.8, diameter 0.7 mm.

Discussion.—Among Recent West American species, the nearest approach to this seems to be *Turbonilla (Pyrgiscus) virgo* Dall and Bartsch (U. S. Nat. Mus. Bull. 68, 1909, p. 93, pl. 8, fig. 4) which has, however, more axial ribs per whorl and stronger basal sculpture than *bravoensis*. All of the Caribbean Miocene species which have been figured appear to be larger and to have more axial ribs per whorl (e.g., *T. (P.) interrupta* (Totten) as figured by Martin, 1904, Maryland Geol. Survey, Miocene, p. 224, pl. 54, figs. 13, 14 and *T. (P.) dominicensis* Gabb from San Domingo, figured by Pilsbry, 1922, Proc. Acad. Nat. Sci. Philadelphia, vol. 73, p. 391, pl. 36, fig. 3).

The name *bravoensis* is taken from the only place name which is shown on the Caliente quadrangle near the collecting locality.

Subgenus Pyrgolampros Sacco, 1892

Type (by original designation): *Pyrgolampros mioperplicatus* Sacco, 1892.

Turbonilla (Pyrgolampros) mariposa Keen, n. sp.
Plate 4, figs. 19, 25

Shell small, elongate-conic; nuclear whorls 2½, helicoid, turned at right angles to spire, only slightly immersed; succeeding two whorls faintly sculptured; remainder of shell with 12 to 14 irregularly sinuous axial ribs crossed by numerous faint spiral grooves; intercostal spaces wider than the ribs; suture a little channeled and wavy; aperture oblique-subquadrate, outer lip thin, joining the twisted columella in a broad curve.

Holotype.—LSJU Paleo. Type Coll. no. 7547; paratype, no. 7547-a.

Dimensions.—Holotype, height (incomplete) 3.1, diameter 1.1; paratype, height 2.8, diameter 0.8 mm.

Discussion.—No comparable Miocene species from the Caribbean area have been described, as the Pyramidellidae of that region have not yet received monographic treatment. Several West American Recent species have been allocated to *Pyrgolampros*; the one most closely resembling *T. (P.) mariposa* is *T. (P.) halibrecta* Dall and Bartsch, 1909 (U. S. Nat. Mus. Bull. 68, p. 65, pl. 5, figs. 10, 10a), which, however, is larger and has more axial ribs on the spire.

The name *mariposa* is from the Spanish, meaning "butterfly."

Genus TYPHIS Montfort, 1810

Type (by original designation): *Purpura tubifer* Bruguière, 1792.

Subgenus TALITYPHIS Jousseaume, 1882

Type (by original designation): *Typhis expansus* Sowerby, 1874 (Pl. 3, fig. 20).

Typhis (Talityphis) lampada Keen, n. sp.
Plate 3, figs. 14, 19, 23

Shell moderately large, spire somewhat low; four varices per whorl, each prolonged at shoulder into a spine; tubules or hollow spines alternating with varices at shoulders of whorls, closer to preceding varices and directed backward away from aperture; varix at outer lip greatly expanded, a little foliated, joined to preceding whorl by a broad rampart which is continuous with inner lip; another rampart reinforces the outer edge of the varix, forming a sutural line along the face of the varix; spiral sculpture of about six faint raised lines on body whorl; aperture elliptical, large; anterior canal long, closed throughout.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7548, collected by Donald Birch; paratype no. 7549 collected by R. T. White; paratype, Calif. Acad. Sci. Paleo. Type Coll. no. 7949, collected by Elizabeth Watson and Lois Martin, all from LSJU loc. 2121. Three additional paratypes, Univ. Calif. Paleo. Type Coll., from UC loc. 2715, Kern River area.

Dimensions.—Holotype, height 24, diameter 16.5, aperture 8.2; paratype no. 7949, height 22, diameter 16.2, aperture 7.3; paratype no. 7549, height 21.5, diameter 16 (estimated), aperture 8.5 mm.

Discussion.—The distribution of *Talityphis* has been commented upon elsewhere in this paper. Here it is more appropriate to mention points of difference which separate *T. lampada* from other members of the subgenus. The genotype of *Talityphis*, *Typhis expansus* Sowerby (Proc. Zool. Soc. for 1873, p. 719, pl. 69, fig. 4, 1874) was described without locality. Specimens collected by A. A. Olsson on the beach at Monte Cristi, San Domingo, compare so closely with the original figure that one may assume the holotype to have come either from San Domingo or from one of the neighboring islands of the West Indies. Spiral sculpture of *expansus* is stronger and the aperture is smaller than in *lampada*. The only other known Recent species of *Talityphis* is *Typhis latipennis* Dall (Proc. U. S. Nat. Mus., vol. 56, no. 2295, 1919, p. 339, holotype figured by Maxwell Smith, *Rock Shells*, 1939, sp. 257, pl. 14, fig. 9), described from U. S. Bur. Fish. Sta. 2822, off La Paz, Lower California, Mexico. The specimens figured on Plate 3, figs. 17, 21, 24, 25 of this paper are virtual topotypes. I have compared these illustrations with the holotype of *latipennis* (no. 96653, U. S. National Museum) and regard the specimens as conspecific.

The earliest described *Talityphis* both geologically and chronologically is *Typhis alatus* Sowerby, 1850 (Quart. Jour. Geol. Soc. London, vol. 6, p. 48, pl. 10, fig. 4), from the Tertiary [Miocene] of Santo Domingo. *Typhis obesus* Gabb, 1873 (Trans. American Philos. Soc., n. s., vol. 15, p. 203, figured by Pilsbry, 1922, Proc. Acad. Nat. Sci. Philadelphia, vol. 73, p. 354, pl. 28, figs. 5-6), from the Miocene of the Dominican Republic is usually regarded as a

low-spired variety of *alatus*. A specimen of *obesus* figured by Olsson as *Typhis alatus* (Bulletins of American Paleo., vol. 9, 1922, p. 304, pl. 13, fig. 15) from Toro Cay, Panama (Gatun formation, Miocene), is refigured here for comparison. Like *T. expansus* it has a smaller aperture and more conspicuous spiral sculpture than *T. lampada*. *Typhis pterinus* Gardner, which seems to be a *Talityphis* (Florida Geol. Survey Bull. 14, p. 52, pl. 10, fig. 10), from the Shoal River Miocene of Florida, has a higher spire than any other *Talityphis*. A Pliocene species has recently been described from the West Coast of Costa Rica.[11]

The name *lampada* (a Latin noun, feminine gender, meaning torch or lantern) was selected in indication of the light which this form throws upon interregional correlation.

GENUS VOLVULELLA Newton, 1891

Type (by subsequent designation, Bucquoy, Dautzenberg, and Dollfus, 1886): *Volvula rostrata* A. Adams, 1850.

Volvulella gluma Keen, n. sp.

Plate 4, fig. 10

Shell spindle-shaped, slender; aperture as long as shell, narrow, anterior end dilated, posterior end extended; at apex a short spine concealing spire; columella with an obscure fold; inner lip slightly reflected over a narrow umbilical groove; sculpture of fine incised lines at both ends of shell, more conspicuous on anterior end.

Holotype.—Stanford Univ. Paleo. Type Coll. no. 7550, from LSJU loc. 2641, R. T. White collector.

Dimensions.—Height 3.4, diameter 1.4 mm.

Discussion.—*Volvulella* (a substitute name for *Volvula* A. Adams, 1850, not Gistel, 1848) has not previously been reported from the Tertiary in California. From Recent West American species *V. gluma* is clearly distinct, *V. californica* Dall (Proc. U. S. Nat. Mus., vol. 56, 1919, p. 298) being larger and of greater diameter and *V. cylindrica* (Carpenter) (Suppl. Rept. British Assoc. Advanc. Sci. for 1863, p. 647, 1864) having a shorter spine at the apex. In the Caribbean Miocene several comparable species occur. *V. oxytata* (Bush) as figured by Woodring (Carnegie Inst. Publ. 385, 1928, p. 125, pl. 2, fig. 10) is proportionately wider than *V. gluma*; *V. marylandica* Martin (Maryland Geol. Survey, Miocene, 1904, p. 134, pl. 39, fig. 6) is larger, with fainter

[11]The description of this species, *Typhis (Talityphis) costaricensis* Olsson (Bulletins of American Paleont., vol. 27, no. 106, p. 228, pl. 25, figs. 5, 8, December 25, 1942), appeared too late for the information to be included in figure 4. The name being preoccupied by *T. linguiferus costaricensis* Olsson, 1922, Dr. Olsson has graciously assigned me the opportunity of renaming the homonym. It gives me pleasure to suggest that this Pliocene species be known as *Typhis (Talityphis) olssoni* Keen, new name. The type locality is the mouth of Quebrada Peñitas, Burica Peninsula, Costa Rica, in beds of probable Pliocene age; holotype, Pal. Research Inst., no. 4064. The species differs from *lampada* in its more slender outline and its smaller aperture.

sculpture; *V. oxytata dodona* (Gardner) of the Chipola Miocene, Florida (U. S. Geol. Survey Prof. Paper 142F, 1937, p. 267, pl. 37, fig. 25) is, likewise, larger than *gluma*.

The name *gluma* is a Latin noun, feminine gender, meaning "husk."

EXPLANATION OF PLATES

PLATE 3

All specimens except those illustrated in figs. 13, 17, 18, 20, 21, 22, 24 and 25 are deposited in Stanford University Paleontological Type Collection.

Fig. 1. *Transennella joaquinensis* Anderson and Martin. Hypotype no. 7528; left valve. LSJU loc. 2121, Round Mountain Silt (Miocene), Kern Co., California. × 4.3. P. 41.

Fig. 2. *Transennella joaquinensis* Anderson and Martin. Hypotype no. 7528-a; right valve. LSJU loc. 2121. × 4.1. P. 41.

Fig. 3. *Dosinia (Dosinidia) margaritana* Weidey. Hypotype no. 7525-a; interior of right valve of juvenile specimen. LSJU loc. 2121. × 7.4. P. 40.

Fig. 4. *Dosinia (Dosinidia) margaritana* Wiedey. Hypotype no. 7525-b; exterior of left valve of juvenile specimen. LSJU loc. 2121. × 7.0. P. 40.

Fig. 5. *Dosinia (Dosinidia) margaritana* Wiedey. Hypotype no. 7525; interior of left valve of juvenile specimen. LSJU loc. 2121. × 6.9. P. 40.

Fig. 6. *Bornia (Temblornia) triangulata* (Anderson and Martin). Hypotype no. 7523; interior of left valve. LSJU loc. 2121. × 4.8. P. 39.

Fig. 7. *Bornia (Temblornia) triangulata* (Anderson and Martin). Hypotype no. 7523-a; interior of defective right valve. LSJU loc. 2121. × 5.1. P. 39.

Fig. 8. *Donax*, n. sp. Hypotype no. 7524; interior of defective right valve. LSJU loc. 2121. × 5.1. P. 39.

Fig. 9. *Nucula (Ennucula) birchi* Keen, n. sp. Paratype no. 7527-a; interior of right valve. LSJU loc. 2121. × 4.3. P. 41.

Fig. 10. *Nucula (Ennucula) birchi* Keen, n. sp. Paratype no. 7527-b; dorsal view. LSJU loc. 2121. × 4.2. P. 41.

Fig. 11. *Nucula (Ennucula) birchi* Keen, n. sp. Exterior of right valve of same specimen as in fig. 9. × 3.1. P. 41.

Fig. 12. *Nucula (Ennucula) birchi* Keen, n. sp. Holotype no. 7527; interior of left valve. LSJU loc. 2121. × 4.3. P. 41.

PLATE 3 (Continued)

Figs. 13, 18, 22. *Typhis (Talityphis) alatus obesus* Gabb. Hypotype, Paleontological Research Inst., Ithaca, New York. Miocene, Gatun formation, Toro Cay, Panama. Fig. 13, view from left side; fig. 18, apertural view; fig. 22, view of spire, showing arrangement of varices and tubes. × 1.6. P. 54.

Figs. 14, 19, *Typhis (Talityphis) lampada* Keen, n. sp. Holotype no. 7548. LSJU loc. 2121. Fig. 14, from left side; fig. 19, from front; fig. 23, from above. × 1.6. P. 53.

Figs. 15, 16. *Lucinisca menuda* Keen, n. sp. Holotype no. 7526. LSJU loc. 2121. Fig. 15, interior of left valve, × 3.0; fig. 16, exterior of same valve, × 3.5. P. 40.

Fig. 17. *Typhis (Talityphis) latipennis* Dall. Hypotype no. 7951 (C.A.S.) from Calif. Acad. Sci. loc. 27585, lat. 23° 02′ north, long. 109° 32′ west, dredged August, 1932, in 25 fathoms a few miles off shore at Gorda Point, San José del Cabo Bay, about 7 miles northeast of Palmilla Point, Lower California. Recent. × 1.1. P. 53.

Fig. 18. See fig. 13.

Fig. 19. See fig. 14.

Fig. 20. *Typhis (Talityphis) expansus* Sowerby. Copy of original figure (Proc. Zool. Soc. London for 1873, 1874, p. 719, pl. 59, fig. 4); holotype probably in British Museum (Nat. Hist.). Type locality unknown, probably West Indies. Dimensions of holotype not recorded by Sowerby; magnification of this figure probably × 1.5 to 2. P. 53.

Fig. 21. *Typhis (Talityphis) latipennis* Dall. Hypotype no. 7950 (C.A.S.) from Calif. Acad. Sci. Sta. 136-D-14 (Eastern Pacific Zaca Expedition), dredged in 45 fathoms on Arena Bank, lat. 23° 29′ 30″ north, long. 109° 25′ west, off Lower California. Recent. Specimen viewed from back. × 1.1. P. 53.

Fig. 22. See fig. 13.

Fig. 23. See fig. 14.

Fig. 24. Same specimen as fig. 21, viewed from above, showing arrangement of varices and tubes.

Fig. 25. Same specimen as fig. 21, apertural view.

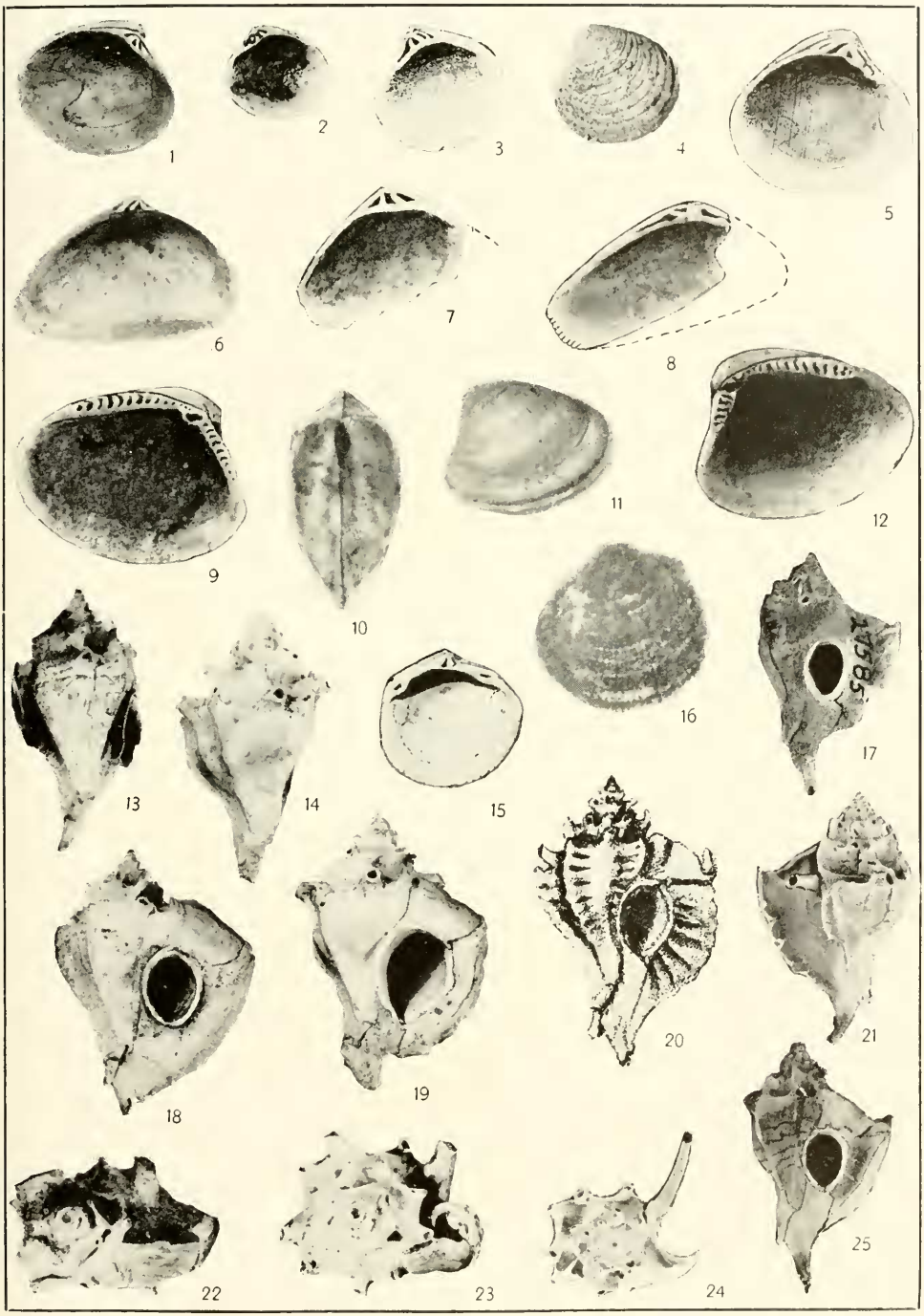
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PLATE 4

All specimens illustrated on this Plate are deposited in the Stanford University Paleontological Type Collection.

Fig. 1. *Anachis watsonae* Keen, n. sp. Holotype no. 7530. LSJU loc. 2121, Round Mountain silt (Miocene), Kern County, California. × 2.7. P. 42.

Fig. 2. Back view of specimen shown in fig. 1.

Fig. 3. *Olivella ischnon* Keen, n. sp. Holotype no. 7542. LSJU loc. 2121. × 2.7. P. 50.

Fig. 4. Back view of specimen shown in fig. 3.

Fig. 5. *Balcis conchita* Keen, n. sp. Holotype no. 7538. LSJU loc. 2121. × 4.2. P. 43.

Fig. 6. *Eulima gabbiana* (Anderson and Martin). Hypotype no. 7543. LSJU loc. 2641, "Barker's Ranch", Kern Co., California. Round Mountain silt (possibly uppermost Olcese sand), Miocene. × 3.3. P. 45.

Figs. 7-9. *Teinostoma (Teinostoma?) lens* Keen, n. sp. Holotype no. 7545. LSJU loc. 2121. Fig. 7, view from above; fig. 8, apertural view; fig. 9, basal view. × 7.1. P. 51.

Fig. 10. *Volvulella gluma* Keen, n. sp. Holotype no. 7550. LSJU loc. 2641. × 7. 3. P. 54.

Fig. 11. *Hastula gnomon* Keen, n. sp. Holotype no. 7536. LSJU loc. 2121. × 2.6. P. 47.

Fig. 12. *Mitrella (Mitrella) anchuela* Keen, n. sp. Holotype no. 7539. LSJU loc. 2121. × 3.8. P. 48.

Figs. 13, 14. *Cylichna temblorensis* Keen, n. sp. Holotype no. 7533. LSJU loc. 2121. Fig. 13, view from above; fig. 14, apertural view. × 7.0. P. 44.

Fig. 15. *Moniliopsis electilis* Keen, n. sp. Holotype no. 7540. LSJU loc. 2121. × 2.5. P. 49.

Fig. 16. *Cylichna? loismartinae* Keen, n. sp. Holotype no. 7532. LSJU loc. 2121. × 7.3. P. 44.

Fig. 17. *Odostomia (Evalea) andersoni* Bartsch. Hypotype no. 7541-a. LSJU loc. 2641. × 6.7. P. 49.

Fig. 18. Back view of specimen shown in fig. 16.

Fig. 19. *Turbonilla (Pyrgolampros) mariposa* Keen, n. sp. Holotype no. 7547. LSJU loc. 2121. × 7.0. P. 52.

Fig. 20. *Turbonilla (Pyrgiscus) bravoensis* Keen, n. sp. Paratype no. 7546-b; nucleus and early whorls of spire. LSJU loc. 2121. × 14.5. P. 51.

PLATE 4 (Continued)

Fig. 21. *Mangelia (Cacodaphnella?) kernensis* (Anderson and Martin). Hypotype no. 7537; showing nuclear sculpture. LSJU loc. 2121. × 19.0. P. 47.

Fig. 22. *Acteon boulderana* Etherington. Hypotype no. 7529. LSJU loc. 2641. × 1.5. P. 42.

Fig. 23. *Odostomia (Evalea) andersoni* Bartsch. Hypotype no. 7541. LSJU loc. 2641. × 6.6. P. 49.

Fig. 24. *Syrnola scandix* Keen, n. sp. Paratype no. 7544-a; showing early whorls of spire. LSJU loc. 2121. × 6.9. P. 50.

Fig. 25. *Turbonilla (Pyrgolampros) mariposa* Keen, n. sp. Paratype no. 7547-a; nucleus and early whorls. LSJU loc. 2121. × 14.0. P. 52.

Fig. 26. *Turbonilla (Pyrgiscus) bravoensis* Keen, n. sp. Holotype no. 7546. LSJU loc. 2121. × 7.5. P. 51.

Fig. 27. *Turbonilla (Pyrgiscus) bravoensis* Keen, n. sp. Paratype no. 7546-a; showing aperture. LSJU loc. 2121. × 7.2. P. 51.

Fig. 28. *Chrysallida rotundomontana* Keen, n. sp. Holotype no. 7531. LSJU loc. 2121. × 6.9. P. 43.

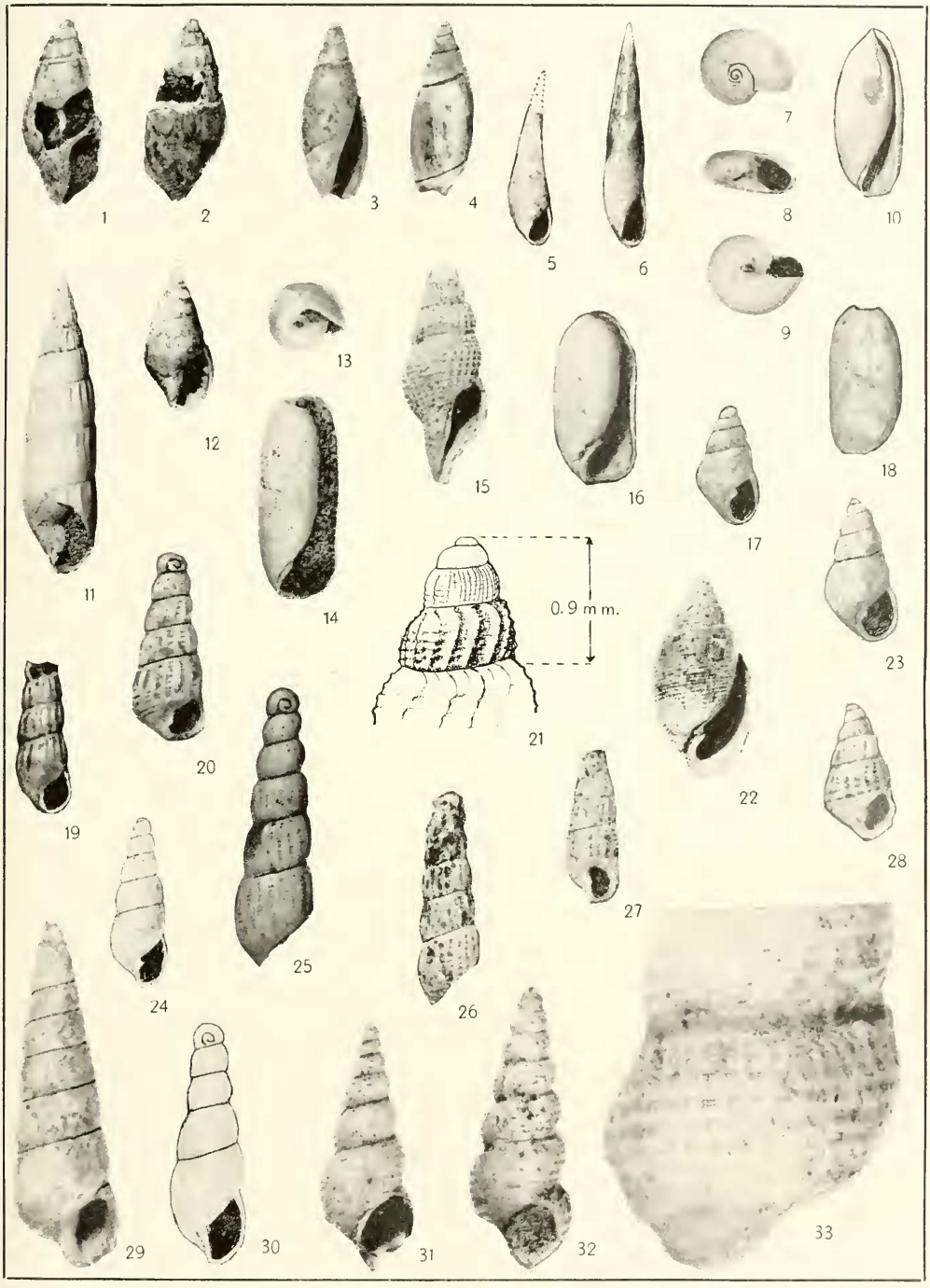
Fig. 29. *Syrnola scandix* Keen, n. sp. Holotype no. 7544. LSJU loc. 2121. × 7.0. P. 50.

Fig. 30. *Syrnola scandix* Keen, n. sp. Paratype no. 7544-b; showing nuclear whorls and early whorls of spire. LSJU loc. 2121. ×15.0. P. 50.

Fig. 31. *Ferminoscala durhami* Keen, n. sp. Holotype no. 7534. LSJU loc. 2121. × 4.0. P. 46.

Fig. 32. *Ferminoscala whitei* Keen, n. sp. Holotype no. 7535. LSJU loc. 2121. × 2.3. P. 46.

Fig. 33. *Ferminoscala whitei* Keen, n. sp. Enlargement of sculpture on back of basal whorls; same specimen as fig. 32.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